

A STUDY OF PREDATION RATES OF LEECHES ON TUBIFICID WORMS UNDER LABORATORY CONDITIONS¹

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Abstract. The objective of this study was to establish the rate at which predatory leeches consume tubificid worms, at worm population densities simulating those of Cleveland Harbor. Two common species of leeches from Lake Erie were studied, *Helobdella stagnalis* and *Erpobdella punctata*. A mixed population of tubificids, mostly *Limnodrilus hoffmeisteri*, *Limnodrilus cervix* and *Pelosclex multisetosus* were used for prey. The mean consumption rate for *Helobdella stagnalis* was 0.57 tubificids/leech/day. The mean consumption rate of *Erpobdella punctata* was 1.78 tubificids/leech/day. Previous studies of the benthos of the Cleveland Harbor reported 11 *Helobdella stagnalis* per square meter of bottom area. Using this number, specimens of *Helobdella stagnalis* were estimated to consume 6.27 tubificids per square meter of bottom area per day at 23.5° C.

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Predation or consuming other organisms is one of several means by which organisms interact to transmit energy. An unstudied, but possibly important, link in the Lake Erie food web is the relationship between tubificid worms and various species of predatory leeches. Very few studies concerning the environment and the behavior of various species of leeches have been done. Brinkhurst and Jamieson (1971), in referring to polluted lakes and streams, suggest that predatory leeches may be "the key to the relatively small numbers of tubificids present at any one time." A more specific study on the biology of the leech *Erpobdella punctata* states that the leech "was often observed eating various types of meat and live individuals of several small species of earthworms" (Sawyer, 1970).

The objective of this study was to establish the actual rates at which predatory leeches consume tubificid worms at worm population densities simulating those of Cleveland Harbor. Estimations of energy flux rates for specific steps in the food web can be based on studies such as this. The results of this study may also aid in determining whether or not tubificids may be significant in con-

centrating toxic elements in the sediments into the food web.

METHODS AND MATERIALS

Bottom samples containing benthos were collected from Station 4 (Rolan, 1973) at the east end of Cleveland Harbor, using a ponar grab. The mud samples were stored in large aquaria and the tubificids were removed as needed. A U.S. No. 30 sieve was used to separate the benthos from the mud. Cultures of tubificids and leeches were maintained throughout the study.

Bacteria were isolated from the mud and mass cultured on nutrient agar. A quantity of mud was autoclaved to kill any tubificid cocoons, which might hatch during the test period and distort the results. The mud was then inoculated with the bacteria previously cultured in order to restore the food supply for the tubificids.

A recent study by Rolan (1973) on the benthos of Cleveland Harbor determined that there were approximately 28,000 tubificids per square meter, or 2.8 per square centimeter, in the area from which the samples were obtained. This population density was selected for the experimental chambers. Beakers of 250 ml (bottom surface area, 33.2 sq cm) were used as test containers, each contained 4 cm of mud and about 4 cm of water at room temperature (23.5°C). To each test container, 100 tubificids and one leech were added. When sorting the tubificids for each test container, great care was taken in choosing medium size tubificids (40-60 mm in length) in order to avoid large tubificids which might slow consumption rates or small tubificids which could easily be missed when recounting. To determine natural death rate or loss from handling, controls were established with 100 tubificids but no leeches. The

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test containers were left for 10 days. At the end of the test period, the contents of each beaker was dumped into a U.S. No. 100 sieve and the tubificids removed and counted. The No. 100 sieve almost completely eliminated the possibility of losing any tubificids during the removal of the mud.

Two different species of leeches were tested. Because of the abundance of the species *Helobdella stagnalis*, more observations were made of it than on the second species *Erpobdella punctata* (Klenn 1972). The tubificids were predominantly three species, *Limnodrilus hoffmeisteri*, *Limnodrilus cervix* and *Pelosclex multi-setosus* based on prior samples from that area (Rolan, 1973).

RESULTS

A total of 14 test containers were set up using the species *Helobdella stagnalis* as the predator. The observed mean consumption rate was 0.63 tubificids/leech/day (table 1). Five control beak-

TABLE 1

The number of tubificids lost in test chambers of each species of leech and controls over a ten day period.

Observation Number	Number of Tubificids Lost		
	<i>Helobdella stagnalis</i>	<i>Erpobdella punctata</i>	Controls
1	7	26	0
2	6	15	1
3	6	19	1
4	6	13	1
5	8	19	0
6	5		
7	9		
8	8		
9	7		
10	4		
11	7		
12	4		
13	6		
14	5		

ers were observed under similar conditions with the mean loss rate being 0.06 tubificids/day. The corrected predation rate or the mean control loss rate subtracted from the observed mean consumption rate for the species *Helobdella stagnalis* was 0.57 tubificids/leech/day. In comparing the means of the test results to those of the control by Student's-t test probability was $P < 0.001$. The calculated Z value was 9.79, well beyond the 2.58 limit for highly significant results.

Five observations were made with the species *Erpobdella punctata*. The observed mean consumption rate was 1.84 tubificids/leech/day (table 1). The mean corrected predation rate was 1.78 tubificids/leech/day and was significant at $P < 0.001$ as compared to controls.

The predation rate per m² of bottom in the sampling area was also calculated for each species of leech. Since there was found to be only one *Erpobdella punctata* per m² of bottom area (Rolan, 1973), the predation rate was 1.78/m²/day. Rolan counted 11 *Helobdella stagnalis* per m² of bottom area. The calculated predation rate for this species thus would be 6.27 tubificids/m²/day 23.5°C.

Several visual observations of the actual method by which the leech consumes the tubificid were made. Common belief suggests that the leech ingests the whole tubificid, but this is not true. The leech attaches itself near one end of the tubificid by means of retractile mouth parts. The leech proceeds to withdraw from the tubificid all its blood and body fluids by a sporadic sucking method. This process is not accomplished without a great deal of thrashing and evasive twisting movements on the part of the tubificid, but usually to no avail. The end of the tubificid furthest from the leech attachment begins to lose color and shrink and when the leech has completed its sucking only a shell of the tubificid is left (resembles a ghost or shadow). Another interesting observation was made while sorting the benthos in an attempt to find the leeches. A common hiding place for the species *Helobdella stagnalis* was inside empty snail shells. This could possibly be a defense mechanism against its own predators.

DISCUSSION

Estimation of predation rates can be considered a method of measuring the amount of input energy of an organism or it can be a measure of the energy outputs of a prey population. Lindemann (1942), in one of his classic studies, concluded that energy lost to predation by any trophic level represents the total amount of assimilable energy passed on to the next trophic level plus a quantity

of energy representing the average content of substance killed but not assimilated by the predator. Murdoch (1971), in a recent article, listed several factors which might affect predation rates and suggested that predation rates were partially a function of prey densities. Cleveland Harbor seems to be an excellent breeding grounds for leeches as far as food availability is concerned. Tubificid densities are very high and ideal for maximum consumption by their predators.

Often predation rates are a function of predator size. Our results lead us to believe that the larger leech *Erpobdella punctata* (0.069 g) consumes more than the small leech, *Helobdella stagnalis* (0.008 g). When comparing the two leeches on the basis of consumption rate per gram body weight, it seems that the smaller predator, *Helobdella stagnalis*, consumes 78.7 tubificids/day/g body weight of leech while the larger leech *Erpobdella punctata* consumes only 25.8 tubificids/day/g body weight. This may be explained by the higher metabolic rate of the smaller organism (Odum, 1971).

The basic design of this study could be used in many other informative experiments. For example, by varying the prey densities, a new set of predation rates may occur. A further study to better support the theory that smaller predators consume more per unit body weight than larger predators would be of interest. A determination of whether or not the leeches have any specific food preference could be studied by changing the prey species. Changing environmental conditions such as temperature, dissolved oxygen or pH to simulate seasonal variations could result in different predation rates.

Our study supports the concept of a predator-prey relationship between tubificids and leeches. How significant a link this relationship is in the overall food web is questionable. It is doubtful that it ranks very high. This is because of the relatively small number of Hirudinea (less than 1% of the total benthic group according to Roland (1971)) found throughout the harbor. The results can be affected by the existence of prey other than tubificids which the leeches may feed on, such as gastropods and insect larvae. Other secondary consumers such as fish are probably a more important link in the food web as well as having an effect on the tubificid population density.

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